X-36 Tailless Fighter Agility Research Aircraft

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The X-36 Tailless Fighter Agility Research Aircraft is a remotely piloted aircraft that was developed to demonstrate that a tailless aircraft, whose aerodynamic and systems configurations are driven by low-observables considerations, often referred to as stealth, can achieve the maneuverability and agility of current-class fighters without the directional stabilization and control power provided by vertical tails.

The 28%-scale X-36 is about 18 feet long, 10 feet wide, and 3 feet high. It weighs 1250 pounds fully fueled. The aircraft is powered by a Williams International F-112 turbofan engine which produces about 700 pounds of thrust.

The aircraft was conceived and developed by Ames Research Center in conjunction with the Boeing Phantom Works. The X-36 Project is an example of a better, cheaper, faster development philosophy, called rapid prototyping, that uses computer-aided design and manufacturing methods to create technologically advanced aircraft on a very short schedule and limited budget. A small, highly skilled, dedicated team designed, built, and shipped two identical X-36 aircraft to NASA Dryden Flight Research Center for flight testing in only 28 months. The total program cost was significantly less than it would have been if more traditional aircraft development methods had been used.

Removing the vertical tails eliminates weight and reduces aerodynamic drag, providing improved aircraft performance. The tailless design also reduces radar signature, an important characteristic for stealthy flight. The aircraft is unstable in both the longitudinal, or pitch, axis and in the directional, or yaw, axis. The X-36 uses conventional aerodynamic control surfaces along with split ailerons and a thrust-vectoring nozzle for aircraft control. An advanced digital flight-control system stabilizes the aircraft.

The X-36 flight-test missions are directed from a ground-control station where the Boeing/NASA test team and the aircraft's pilot are located. The aircraft is remotely piloted using a virtual cockpit. A monitor directly in front of the pilot provides out-the-nose video imagery downlinked from the aircraft. A head-up display is overlaid on the video image to provide flight-critical information. The cockpit displays provide the pilot with excellent situational awareness, making maneuvering flight and precision landings routine. The X-36 takes off and lands conventionally from the lake-bed runways or from the main base runway at Edwards Air Force Base.

The first flight of the X-36 was made on May 17, 1997. The flight was preceded by several months of hardware integration testing, structural modes interaction (SMI) testing, hardware in-the-loop simulations, piloted simulations, test team training, and ground taxi tests. By September 30, 1997, the aircraft had completed a total of 22 flights with a total flight time of 10 hours 54 minutes at angles of attack up to 40 degrees. The rate at which these test flights were flown and the rapid expansion of the flight envelope were made possible by using analysis programs during flight that verified the performance of the flight-control system in stabilizing the aircraft. Data on the aerodynamic characteristics of the X-36 were also generated using sophisticated parameter identification techniques. The photograph shows the X-36 in flight above Rogers Dry Lake bed, Edwards Air Force Base, California.

At the test altitude of 17,000 feet, fighter-type maneuvers such as 360-degree rolls and rolling pullouts were performed to demonstrate the agility of the X-36. A rolling pullout is a classic maneuver when dogfighting. The aircraft is banked sharply in one direction, then quickly rolled in the opposite direction while pulling g's. Classified flight-test data

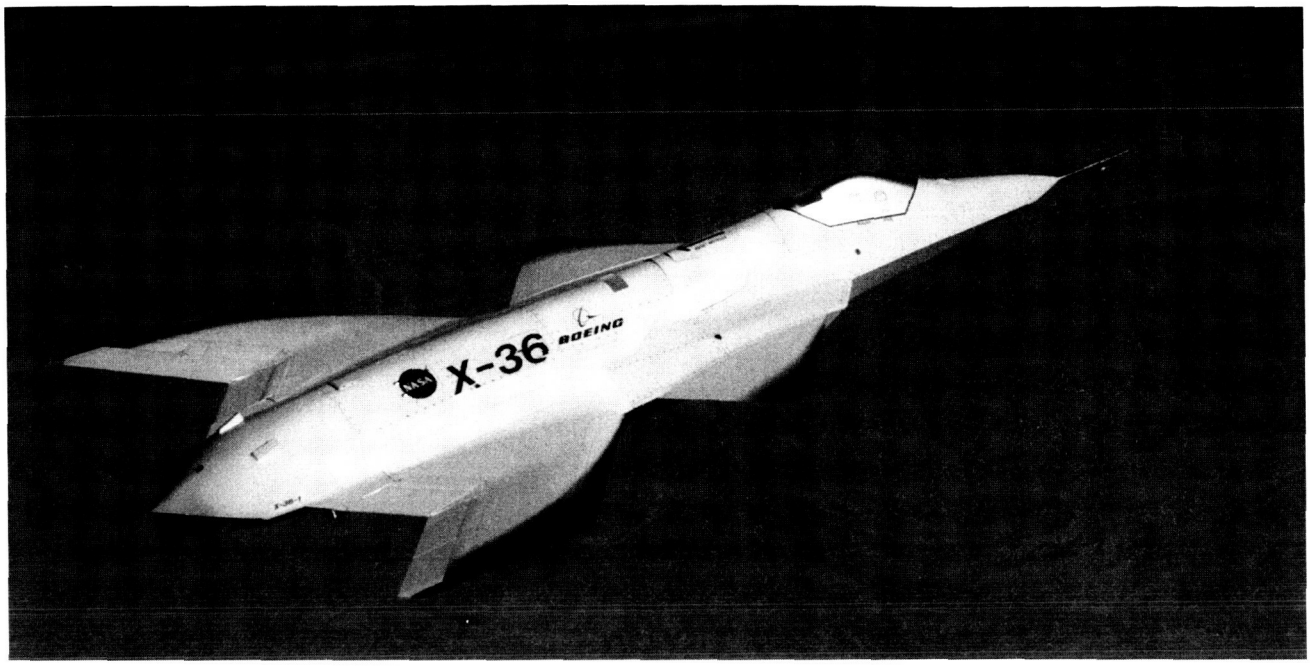

Fig. 1. The X-36 Tailless Fighter Agility Research Aircraft in flight over Rogers Dry Lake bed, Edwards Air Force Base, California.

show that the X-36 aircraft successfully demonstrated that a tailless aircraft can achieve levels of agility and maneuverability exceeding those of present-day fighters.

The X-36 is also an excellent example of how subscale, remotely piloted aircraft can demonstrate advanced technologies at a fraction of the cost and development time required by full-scale aircraft with the pilot aboard. The X-36 Project was a complete success and provides a preview of what fighter aircraft of the future will look like.

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Aeronautics Design/Test Environment Condition-Based Maintenance for the 12-Foot Pressure Wind Tunnel

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In support of the Aeronautics Design/Test Environment effort to enhance operations at wind tunnel facilities, researchers collaborating with wind tunnel experts implemented a software application to monitor system performance and to diagnose anomalous behavior in the make-up air (MUA) compressor subsystem of the 12-Foot Pressure Wind Tunnel at Ames Research Center. This project combined the efforts of the System Health Management team, the Ames Fluid Mechanics Laboratory, and the Applied Research Laboratory at Pennsylvania State University. Condition-based maintenance (CBM) can increase facility efficiency by reducing or eliminating costly repairs required because of unnecessary maintenance and failures. CBM is a systematic approach that focuses on continuous monitoring of equipment combined with model-based reasoning software to indicate the need for maintenance that, if ignored,